



LIQUIFIED GAS STORAGE TANKS

**Construction and possible use
for the physics experiment**

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CB&I**





CB&I

- A global engineering and construction company specializing in the design and engineering, fabrication, field erection and repair of bulk liquid terminals, steel tanks, pressure vessels, **low temperature and cryogenic storage facilities** and other steel structures and their associated systems.



CB&I

- **Founded in 1889**
- **Global Execution Capabilities**
- **1.8 Billion US \$**
- **Working in 30 Countries**
- **Design / Built over 30,000 storage tanks**
- **1,100 Low Temperature & Cryogenic Applications (tanks, systems, & terminals)**
- **33 LAR Tanks & Vessels**



CB&I

- **FERMI Laboratory Experience**
 - **BooNE Detector Containment Sphere**
 - **Vacuum Decay Tube**





Agenda

- Common Tank Configurations
- Tank design standard
- Common Containment Options
- Issues for FLARE
 - Size
 - Soil Bearing
 - Purity
 - Materials
 - Internal operating pressure
 - Installation of internals
 - Support of internals
 - Tank Integrity –
 - Spills
 - Tank Nozzles
 - Heat Loss



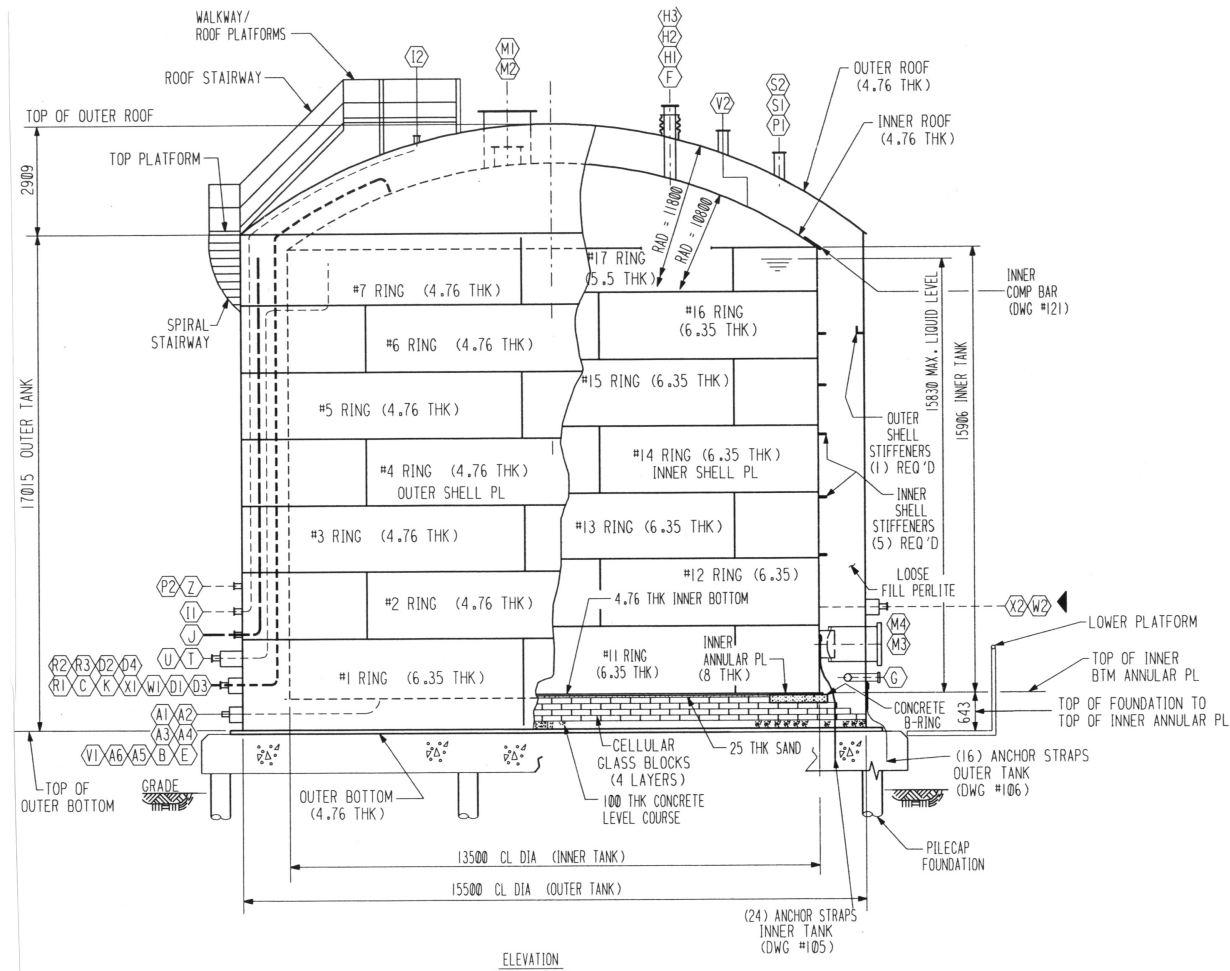
Common Tank Configurations

- **LIN & LAR Tanks**
 - **Double Wall Double Roof - Standard**
 - **Double Wall Suspended Deck – large Tanks**
- **LNG Tanks**
 - **DWSD**



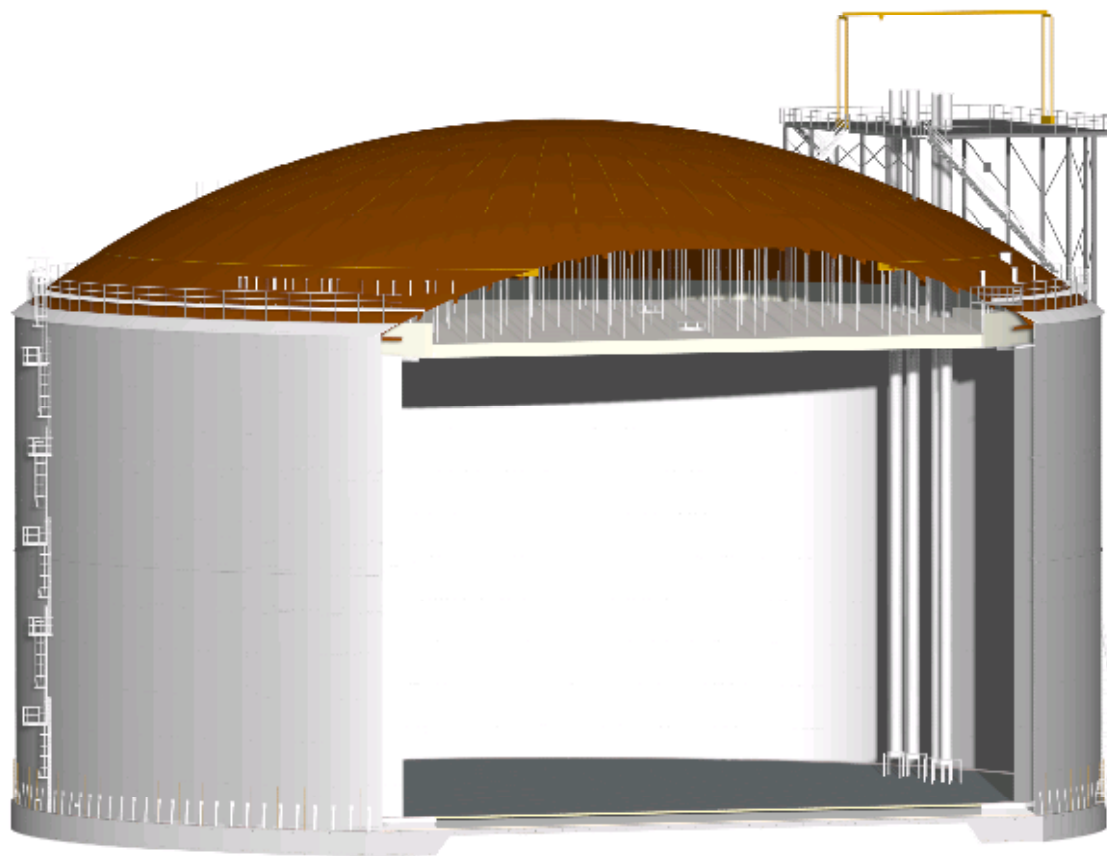


Double Wall Double Roof LIN Tank





Double Wall Suspended Deck LNG Tank





Tank design standard

- API 620 Q
- CGA P-25 – 1999
- Owner specific

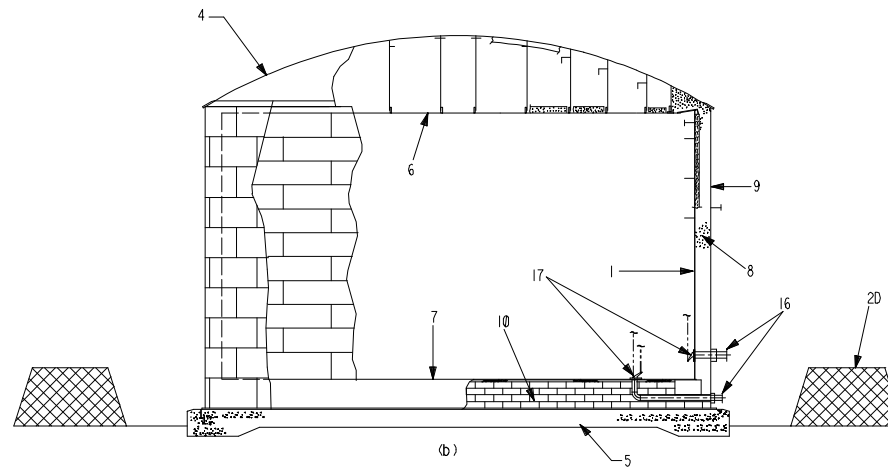
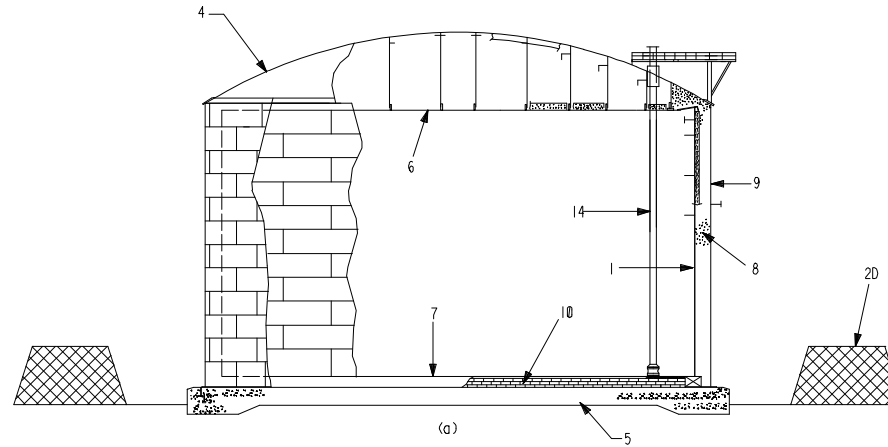




Common Containment Options

- **Single Containment**
 - Steel primary and secondary
- **Double Containment**
 - Steel Primary; steel of concrete secondary
- **Full Containment**
- **Drivers**
 - Site restrictions
 - External design conditions (such as penetration by projectile)
 - Safety issues
 - Vapor dispersion
 - Fire radiation



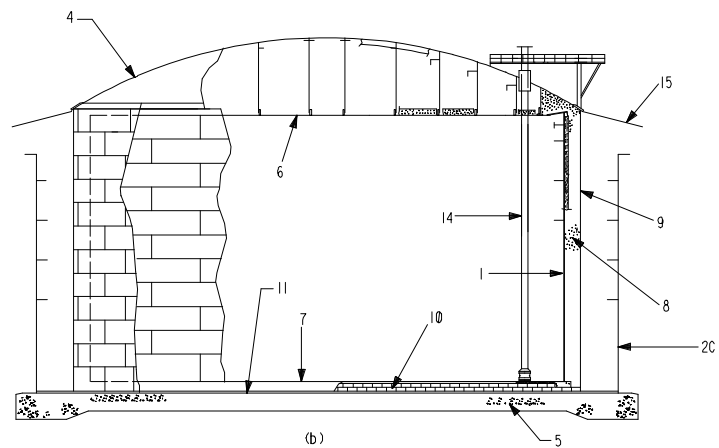
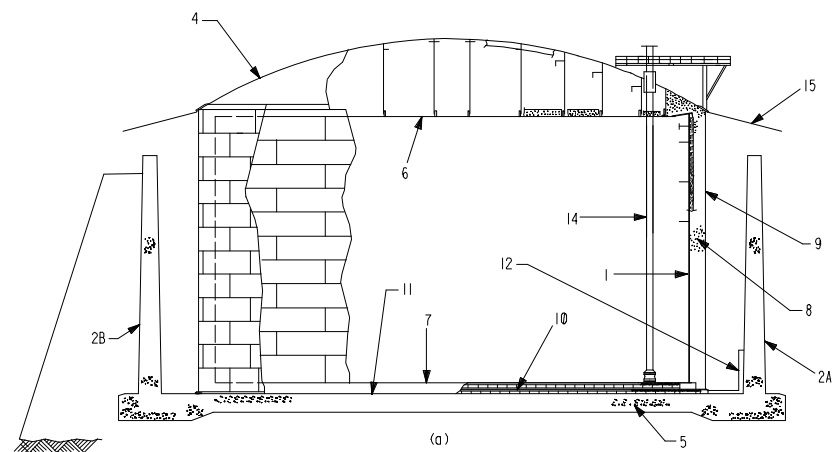


KEY

- 1 PRIMARY CONTAINER (STEEL)
- 20 BUND WALL (SECONDARY CONTAINER)
- 4 ROOF (STEEL)
- 5 FOUNDATION (REINFORCED CONCRETE)
- 6 SUSPENDED DECK (INSULATED)
- 7 PRIMARY CONTAINER BOTTOM

- 8 INSULATION
- 9 OUTER SHELL (INSULATION/VAPOR CONTAINER)
- 10 BOTTOM INSULATION
- 14 PUMP COLUMN
- 16 BOTTOM OUTLET/SHELL NOZZLE
- 17 IN-TANK SHUT OFF VALVE

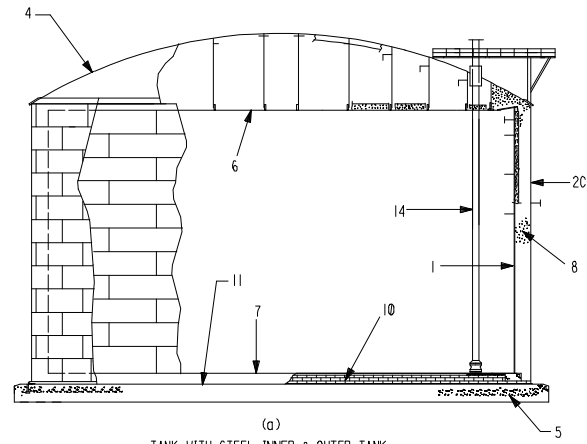
EXAMPLE OF SINGLE CONTAINMENT TANK



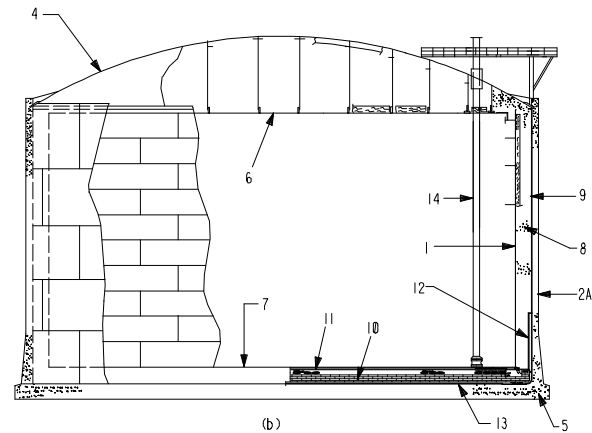
KEY

- | | |
|---|---|
| 1 PRIMARY CONTAINER (STEEL) | 8 INSULATION |
| 2A SECONDARY CONTAINER (PRESTRESSED CONCRETE) | 9 OUTER SHELL (INSULATION /VAPOR CONTAINER) |
| 2B SECONDARY CONTAINER (REINFORCED CONCRETE W/EARTH BERM) | 10 BOTTOM INSULATION |
| 2C SECONDARY LIQUID CONTAINER (STEEL) | 11 SECONDARY CONTAINER BOTTOM |
| 4 ROOF (STEEL) | 12 THERMAL CORNER PROTECTION |
| 5 FOUNDATION (REINFORCED CONCRETE) | 14 PUMP COLUMN |
| 6 SUSPENDED DECK (INSULATED) | 15 COVER (RAIN SHIELD) |
| 7 PRIMARY CONTAINER BOTTOM | |

EXAMPLE OF DOUBLE CONTAINMENT TANK



(a)
TANK WITH STEEL INNER & OUTER TANK



(b)
TANK WITH STEEL INNER TANK, CONCRETE OUTER WALL AND STEEL ROOF

KEY

- | | |
|--|-------------------------------|
| 1 PRIMARY CONTAINER (STEEL) | 9 WALL LINER |
| 2A SECONDARY CONTAINER (PRE STRESSED CONCRETE) | 10 BOTTOM INSULATION |
| 2C SECONDARY CONTAINER (STEEL) | 11 SECONDARY CONTAINER BOTTOM |
| 4 ROOF (STEEL) | 12 THERMAL CORNER PROTECTION |
| 5 FOUNDATION (REINFORCED CONCRETE) | 13 VAPOR BARRIER |
| 6 SUSPENDED DECK (INSULATED) | 14 PUMP COLUMN |
| 7 PRIMARY CONTAINER BOTTOM | |
| 8 INSULATION | |

EXAMPLE OF FULL CONTAINMENT TANK



Issues for FLARE

- **Size**
 - 35,000 m³
 - 40m dia X 30m high
- **Soil Bearing**
 - need minimum of 12,000 PSF
- **Purity**
 - Tank cleaning – materials issues
 - Purging & Cool down
 - Operation
- **Materials**
 - 9% Ni (approx 37mm lower shell)
 - Common for very large LNG tanks
 - 300 series SS (approx 55mm lower shell)
 - Common for LOX clean conditions



Issues for FLARE

- **Internal operating pressure**
 - Minimum must be greater than ambient pressure fluctuations
 - Increase due to operating fluctuations & flash from liquid additions
- **Heat gain – Design of insulation system**
 - Liquefaction of boil off
 - Foundation heating – operating cost



Issues for FLARE

- **Installation of internals - Options**
 - Install all major components before test
 - Install components through the roof after inner tk hydrotest & before Pneumatic outer tk test
 - Special opening in tank shell
 - Installation before or after tank cleaning?
- **Support of internals**
 - Approx 300 Tons supported from above
 - Flat inner roof
 - Not recommended for a pressure container
 - Recommend Suspended Deck





Issues for FLARE

– Tank Integrity –

- Hydrotest does not subject tank to operating levels.
- Added shell weld integrity - UT in place of RT
- Added geotechnical testing and safety factors for bearing strength

– Spills

- External pipe failure
 - Remote operable valve
 - Internal tank valve
- Overfill or Inner tank leak
 - Containment type





Issues for FLARE

- **Tank Nozzles**
 - **Withdrawal**
 - Under bottom
 - Side
 - Internal Pump
 - **Roof Penetrations**
 - Locations near tank perimeter
 - 50 – 24” dia nozzles OK for 40 m dia tank



In-tank Pump Wells – LNG Tank





Questions

